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PROCESS AND APPARATUS FOR FORMING IMAGES

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image forming process for forming a protective layer of a thermoplastic resin film on a recording medium and an image forming apparatus for carrying out this process.

Related Background Art

In recent years, the progress of the ink-jet recording technique is noteworthy and its image quality has reached a level equal or superior to that of a silver halide print. As to recording media used for this ink-jet recording process, those with an image-receiving layer, containing porous particles excellent in absorbing and fixing recording liquid, provided on a base material such as paper are known.

Besides, a laminating treatment of a recorded image by transferring and laminating a transfer layer comprising a thermoplastic resin layer provided on a base material onto a recorded image by heat and pressure adhesion to give waterproof, light resistance, glossiness, etc. is also known. By having a UV absorbing agent contained in the transfer layer during this treatment, it is also possible to provide a sufficient light resistance to a print. Furthermore, by devising the material and constitution of this

transfer layer, many laminating treatments of an image for simply and easily providing the wear resistance, solvent resistance, or the like by use of a resin have been worked out thus far.

FIGS. 3A to 3C are schematic sectional views of a conventional laminating method. The film with a base material shown in FIG. 3A basically comprises a transfer layer 101 to be transferred and laminated onto the surface of a recorded image and a base material film 102 for bearing the transfer layer 101. The transfer layer 101 can be peeled off from the base material 102 so as to be transferred and laminated onto the image-receiving layer of a recording medium after recording.

As shown in FIG. 3B, the transfer layer 101 is laminated while remaining borne on the base material film 102 so as to directly cover the top of the image-receiving layer 103a on an ink-jet image-receiving paper 103 after recording and applied onto the image-receiving layer 103a by pressurization and/or fusion.

As shown in FIG. 3C, the base material layer 102 is peeled off from the transfer layer 101 after the transfer layer is applied onto the recorded image, and the transfer layer 101 alone is left as a protective layer on the image receiving layer 103a.

The principal problem of the construction

comprising a transfer layer 101 and a base material film 102, as shown in FIGS. 3A, 3B and 3C, is high cost. In a laminating treatment as mentioned above, a base material film comprising a heat resistant material is necessary for the base material film 102 on which a resin layer to be transferred by heat and pressure adhesion on the recording side is formed by coating. In this film, not only heat resistance but flatness sufficient for giving the gloss of a protective film after the transfer is also required, thus resulting in high cost. The cost of this base material film 102 has a much greater weight than that of a transfer material remaining as a final product or that of coating of a transfer layer. Sufficiently stable and deformation-free raw material of a protective layer under conditions assumed for the thermal transfer, includes PET film, polyamide film, polyimide film and so on with thermal shrinkage controlled by preannealing, but any of them is a high-cost material. With such a constitution, a wide variety of applications truly low in cost and highly general in purposiveness are difficult to create.

The second problem of this constitution lies in that the base material film 102 becomes a used waste. From the viewpoint of processing cost, coating of a transfer layer 101 is ordinarily executed on a wide roll before slitting. Thus, recycling of used base

material films 102 cannot be directly performed. Supposing that used basic films 102 are recycled, they would be done on the level of raw materials. Thus, it costs labor to collect and recycle them. Besides, a mechanism for rewinding a film after the image transfer in an apparatus, a space for disposing the mechanism, a power source for moving the mechanism or control system and so on are necessary. In a case where a laminate material has been cut, winding is unnecessary, but a mechanism for carrying used basic films 102 and accumulating them in a predetermined space is still necessary.

The third problem of this constitution lies in that the function of a protective layer transferred and formed varies according to the physical property, surface property, thickness or the like. These especially affect the glossiness, the adhesion of a film and the bubble releasability to a great extent. Originally, the transfer process of a glossy protective layer is a complicated process in which many parameters contribute, so that addition of such an influential variable factor is unfavorable to the stability of phenomena.

SUMMARY OF THE INVENTION

It is one object of the present invention to provide an image forming process and an image forming

apparatus capable of solving the problems mentioned above and forming an image good in glossiness at low cost and free of used wastes.

An image forming process according to the present invention comprises the steps of conducting recording on a recording medium with an image-receiving layer and laminating a thermoplastic film onto the image-receiving layer to smooth the surface of the thermoplastic film by heating and pressurizing means.

An image forming apparatus according to the present invention comprises: an ink-jet head for conducting recording on a recording medium; a laminating section for laminating a thermoplastic polymer onto a recording medium on which recording has been conducted; and heating and pressurizing means for heating and pressurizing the thermoplastic film to smooth the surface.

In the present invention, a thermoplastic resin film alone is laminated without use of a base material film that has been heretofore used, and the surface of a protective layer is smoothed during the lamination, so that the cost can be reduced and a glossy fine recorded image can be obtained.

Besides, a film itself is laminated and heat from heating means is directly transmitted not by way of a base material film, thereby reducing the thermal load of the apparatus or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of one example of an image forming apparatus according to the present invention.

FIGS. 2A and 2B are illustrations of one example of a device for manufacturing a thermoplastic film used in the present invention.

FIGS. 3A, 3B and 3C are illustrations of one example of method for laminating a laminate film with a base material attached.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the apparatus shown in FIG. 1, recording media 2-1 and 2-2 different in size are fed from storing cassettes 1-1 and 1-2 by means of first and second feed rollers 3-1 and 3-3. Furthermore, through conveyance guides 7-1 and 7-2, rollers 4, a conveyance guide 8, rollers 5 and a conveyance guide 9, they arrive at an ink-jet recording head 12. Here, in accordance with an image signal from unshown image reader means, images are recorded on the image-receiving layer of the recording media 2-1 and 2-2. The recording head 12 is composed of so-called multi-heads arranged in a full line, for example, nearly perpendicular to the recording media 2-1 and 2-2, i.e. vertical to the paper plane in FIG. 1. In this ink-jet recording, the recording media 2-1 and 2-2 are sucked to a porous

guide plate 14 by a suction fan 13 to retain their planarity and keep their gap to the recording head 12 best.

Furthermore, the recording media 2-1 and 2-2 after recording are conveyed through a conveyance guide 10, conveyance rollers 6 and a conveyance guide 11 to a laminating section.

On the other hand, a long-scale thermoplastic resin film 22 is wound onto a thermoplastic resin film feed section 21 in the shape of a drum. This thermoplastic resin film 22 has a width corresponding to a length perpendicular to the conveying direction of the recording media 2-1 and 2-2. This thermoplastic resin film 22 is fed from the feed section 21 through feed rollers 23, a cutter 24, conveyance rollers 25 and conveyance rollers 26 and overlapped with the recording media 2-1 and 2-2 after recording by means of rollers 27. Besides, the thermoplastic resin film 22 is cut at a desired position by means of the cutter 24.

Furthermore, both of them overlapped by means of the rollers 27 are conveyed to pressurizing roller 28 containing a heater 29 built in and heated and pressurized for adhesion. Namely, onto the image-receiving layer of the recording media 2-1 and 2-2, the thermoplastic resin film 22 is laminated and then bonded. The laminated recording media 2-1 and 2-2 are discharged through rollers 32 to a discharge tray 33.

Here, when smoothing the surface of the protective layer to improve the glossiness of images, the pressurizing rollers 28 serving as heating and pressurizing means smooths the surface on the side in contact with the thermoplastic resin film 22. In order to obtain glossy images, the surface roughness of the pressurizing rollers is preferably about 3 μm or less in terms of Ra and much preferably about 1.5 μm or less.

In the present invention, because of directly determining the glossiness of the transfer protective layer (accordingly, of recorded images), the surface glossiness of rollers is an important factor. This glossiness depends on that of images required, but generally is preferably equal to or greater than 10% at an incident angle of 20° and is equal to or greater than 70% at an incident angle of 75°.

Besides, the temperature of heating by heating and pressurizing means has to be determined appropriately depending on material of a thermoplastic resin film 22, but is preferably in the range of 60 to 220°C ordinarily.

The surface material of this pressurizing roller pair 28 on the side of a thermoplastic resin film is preferably heat resistant rubber. With a metal roller, once flaws are generated on the surface, their shapes are transferred, but they are closed by pressure in a

material of rubber, thus improving the durability significantly. Furthermore, from the viewpoint of mold releasability, silicon rubber is preferable, and applying traces of silicon oil is effective significantly in point of maintaining and improving the mold releasability.

Devices for forming a protective layer, used in the present invention are not limited to the example shown in FIG. 1. For example, a charged drum is used as intermediate carrier and a device so arranged as to push this charged drum wrapped with a thermoplastic film 22 therearound to the recording media 2-1 and 2-2 can be also employed.

Any thermoplastic film which can be laminated on a recorded image-receiving layer of a recording medium may be employed for thermoplastic resin films used in the present invention without any limitation. Thermoplastic resin films having preferable characteristics for lamination such as transparency, breaking strength and melting point have to be appropriately selected for use. Specifically, films of vinyl chloride-vinyl acetate copolymer, polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyesters, polyvinyl alcohols, polyamides, cellulose acetate, polycarbonates, polyvinyl butyral, vinylidene chloride or the like can be exemplified.

Besides, it is preferable either that the glass

transition point of a thermoplastic resin film is lower than that of a binder resin of an image-receiving layer in a recording medium or that the film-forming temperature of a thermoplastic resin film is lower than that of a binder resin of an image-receiving layer in a recording medium respectively.

The thickness of a thermoplastic resin film may be determined appropriately, but is preferably such thickness that the uneveness of the surface of the image-receiving layer in a recording medium does not appear on the surface of the thermoplastic resin film; to be specific, it is preferably in the range of 2 to 40 μm.

Besides, a thermoplastic resin film may be composed of a laminate of different thermoplastic polymer layers. In this case, ordinarily, the glass transition point or film-forming temperature varies among the thermoplastic polymer layers. Thus, a thermoplastic layer much lower in glass transition point or film-forming temperature may be laminated onto the image-receiving layer. And in this case, the thickness of a thermoplastic polymer layer on the laminated side to the image-receiving layer is preferably such thickness that the uneveness of the surface of the image-receiving layer does not appear on the surface of the thermoplastic resin film; to be specific, it is preferably in the range of 1 to 20 μm.

Besides, the total thickness of a thermoplastic resin film is preferably in the range of 2 to 40 μm.

By setting the polymer layer on the side directly laminated onto an image-receiving layer to a material low in glass transition point, a resin can be so arranged as to firmly intrude into concave portions of an uneven image-receiving layer; on the other hand, by using a polymer material high in glass transition point and molecular weight for the layer on the opposite side, the surface hardness of the laminate layer can be enhanced. Besides, such composition of two layers or more is advantageous also from the viewpoint of preventing the inter-layer fusion in the stock of a thermoplastic resin film wound in the shape of a roll.

FIGS. 2A and 2B are schematic illustrations exemplifying a process for manufacturing a thermoplastic resin film used in the present invention.

FIG. 2A shows an example of manufacturing a monolayer thermoplastic resin film. As shown in FIG. 2A, a monolayer thermoplastic resin film is obtained by supplying a thermoplastic resin material from a dye coating head 51 to a casting roll 52 and winding a shaped film on a winding roll 53. By using a casting roll 52 in this manner, the film surface is well smoothed, and images after the formation of a protective layer further improves in glossiness.

FIG. 2B shows an example of manufacturing a double

layer thermoplastic resin film. As shown in FIG. 2B, a double layer thermoplastic resin film is obtained by supplying a thermoplastic resin material from a dye coating head 51 to a casting roll 52, further coating a second layer by means of a micro gravure coating head 54, drying the coat in a drying furnace 55 and winding the shaped film on a winder roll 53.

The examples shown in FIGS. 2A and 2B are so arranged as to wind a manufactured thermoplastic resin film in the shape of a roll and laminate this rolled thermoplastic resin film onto an image-receiving layer installed at the supply section 21 of the laminating apparatus shown in FIG. 1, but a thermoplastic resin film may also be so arranged as to be continuously supplied from the casting roll 52 to the apparatus shown in FIG. 1 without being wound in the shape of a roll.

The image-receiving layer of a recording medium used in the present invention is mainly composed of porous inorganic particles and binder resin, where 30 ~~to 100 parts~~ to 1000 parts by weight preferably 50 to 500 parts by weight of binder resin is employed with respect to 100 parts by weight of porous inorganic particles.

As to porous inorganic particles, those containing a large amount of pores having 3 to 30 nm diameter in the structure are preferable, especially those having large pore density near the particle surface are

preferable. Furthermore, from the viewpoint of obtaining a sufficient ink absorption rate or the like, the specific surface area of porous inorganic particles is preferably 50 m^2/g or larger. Furthermore, in use of high-speed printing ink-jet printer, the image-receiving layer of a recording medium preferably contains 50% by weight or more of porous inorganic particles with the specific area of $100m^2/g$ or greater from the viewpoint of preventing the overflow of ink or the like.

The porous inorganic particles endowed with such an ink solvent absorptivity and dye-molecule absorptivity preferably take on white color further. As to the material comprising porous inorganic particles having such characteristics, metals such as aluminum, magnesium and silicon and oxides, hydrates, carbonates or the like of metals can be exemplified. Above all, synthetic silica is particularly preferable on account of excellency in all the characteristics mentioned above, established industrial production process, inexpensiveness and stability.

With an image-receiving layer comprising a mixture of such inorganic particles and an organic binder resin, not quite small diameter of inorganic particles is preferable from the viewpoint of ink absoptivity or the like. In many cases, inorganic particles in the range of 0.1 to 10 μm in diameter are employed and not

sufficiently small relative to the wavelength of light, so that light scattering takes place on the surface to show a matted appearance. Among them, ultrafine particles in the range of 0.1 to 1 μm in diameter provide a glossy surface rather reduced in matt in some cases, but usually, a secondary aggregation of particles occurs, so that the suface can not be smoothed so much. Besides, if a dispersant is added to the coating liquid for the purpose of preventing the aggregation, the absorptivity of ink or the stability of dye molecules are often damaged.

For these reasons, the surface of a recording medium containing such porous inorganic particles in which a high-speed absorptivity of ink and a coloring stability of dyes have been investigated is normaly matted. The present invention displays considerable meritorious effects in the case of using a recording medium containing such image-receiving layers.

Hereinafter, examples of the present invention will be described.

Example 1

Two parts of binder resin emulsion (Takamatsu Yushi; NS120-XK) was added to 1 part of silica (Mizusawa Chemical Industries; Mizukasil P-50), thereafter the mixture was dispersed to prepare a coating liquid so that the solid content became 20% by weight. This coating liquid was coated and dried onto

fine paper of 186 g/m^2 by means of a slot-dye coator so that a film after the drying became 30 μm thick to form an image-receiving layer.

Next, an 8 μm thick thermoplastic resin film made of vinyl chloride-vinyl acetate copolymer was used to carry out ink-jet recording and the formation of a protective layer by means of the apparatus shown in FIG. 1. The film-forming temperature of the film material was 60°C. The temperature of pressurizing rollers 28 having a silicon rubber surface during lamination was set to 140°C and the glossiness of the pressurizing roller 28 on the side of the thermoplastic resin film was set to 80% at an incident angle of 75°. As a result, recording images excellent in glossiness could be obtained.

Comparative Example 1

The same vinyl chloride-vinyl acetate copolymer as used in Example 1 was coated on a 38 μm thick polyethylene terephthalate film with the same thickness, thereby preparing a film with a base material as shown in Figs. 3A to 3C. The unevenness of the polyethylene terephthalate film was the same as that of the pressurizing rollers used in Example 1. Using this film, ink-jet recording and the formation of a protective layer were carried out as in Example 1, and three times the heating energy of that in Example 1 was required in order to obtain the same glossiness as

in Example 1.

As clearly seen from the results of Example 1 and Comparative Example 1, the present invention does not use a film with a base material prepared by laminating a material for lamination onto a heat resistant film as in Example 1, but directly laminates only a material for lamination using rollers by heat and pressure adhesion, which brings forth high thermal efficiency and makes it possible to obtain recorded images having good glossiness at low cost.

Example 2

Except that a thermoplastic resin film comprising two layers of a 3 µm thick layer made of low molecular weight acrylic resin and a 10 µm thick layer of vinyl chloride-vinyl acetate copolymer was used, the temperature of pressurizing rollers 28 was set to 120°C and the side of vinyl chloride-vinyl acetate copolymer was brought into contact with the image-receiving layer, ink-jet recording and formation of a protective layer were carried out as in Example 1, then similar good results were obtained.

In this example, it is important to fully plasticize the acrylic resin layer by means of the pressurinzing rollers 28. Thereby, the lower vinyl chloride-vinyl acetate copolymer layer is sufficiently solved into the upper acrylic resin layer so as to make the interface disappear, and thus the density of

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recorded images can be improved by eliminating the light scattering on the interface between the above two layers. Besides, the blocking of a relatively high Tg acrylic resin layer is prevented so that a highly uniform film is completed.

As described above, according to the present invention, a thermoplastic resin film without a base material is laminated and the surface of a protective layer is smoothed during laminating, so that a good glossy protective layer can be formed at a low cost and without used wastes.

Moreover, since a film itself is laminated and the laminated film does not have a base material, heat from heating means is directly transmitted so that thermal load of an apparatus or the like is reduced.